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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 10/800,112 | 03/12/2004 | Yuxiang May Wang | 008245/DSM/BCVD | 8920 |

44257 7590 05/23/2007

PATTERSON & SHERIDAN, LLP
3040 POST OAK BOULEVARD, SUITE 1500
HOUSTON, TX 77056

| EXAMINER | |
|---|---|
| ANGADI, MAKI A | |

| ART UNIT | PAPER NUMBER |
|---|---|
| 1765 | |

| MAIL DATE | DELIVERY MODE |
|---|---|
| 05/23/2007 | PAPER |

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/800,112 | WANG ET AL. | |
| | Examiner | Art Unit | |
| | Maki A. Angadi | 1765 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *27 February 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1,3-5,7-9,11-13,15-21,23 and 24* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1, 3-5, 7-9, 11-13, 15-21, 23 and 24* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

## DETAILED ACTION

### *Claim Rejections - 35 USC § 103*

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

1. Claims 1, 3-7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dakshina-Murthy et al. (US 6,884,733) in view of Godet, *Jounal of Applied Physics, Vol.84, 3919, (1998),* and Lee (US Patent No. 6, 043,167).

*As to claim 1,* Dakshina-Murthy discloses use of amorphous carbon hard mask for gate patterning, the method comprises forming a conductive material layer (50) on a surface of the substrate (column 4, lines 53-64), depositing an amorphous carbon layer (60) on the conductive material layer (column 5, line 42)

by a method comprising: introducing into the processing chamber one or more hydrocarbon compounds having the general formula CxHy such as Ethylene or propylene (column 5, line 48). And generating a plasma of the one or more hydrocarbon compounds (column 5, line 49), etching the amorphous carbon layer to form a patterned amorphous carbon layer (figure 8); and etching feature definitions in the conductive material layer (col.8, lines 38-43) corresponding to the patterned amorphous carbon layer (figure 9).

Dakshina-Murthy fails to disclose a dual-frequency plasma for the PECVD deposition. However, Godet describes a process where a dual-frequency plasma is used for deposition of an amorphous carbon layer using Ar-$H_2$ or Ar-He gas mixtures (pages 3920-3921). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the process of Dakshina-Murthy to use the dual-frequency method of Godet for forming the amorphous carbon layer because Godet teaches dual-frequency is conventionally used for amorphous carbon layer deposition. One of ordinary skill in the art would have been motivated to use a dual-frequency deposition method in order to obtain a high-quality dense deposit yielding a compact structure (page 3391, col.1, paragraph 2), which is attributed to the increasing energy of the impinging ion during film growth.

Dakshina-Murthy fails to disclose the first frequency between about 10MHz-30MHz and second frequency between about 100KHz-500KHz. However, Lee discloses the dual frequency of about 13.56 MHZ for the first

frequency and about 10KHz-100Kz for the second frequency (col.3, lines 48-59). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to select dual frequency values for the RF source because Lee illustrates that the low dielectric constant insulating films such as amorphous fluorocarbon film when deposited with a dual frequency RF source result in a stable low-k film at least up to 450°C with low internal stress (col.3, lines 1-3).

*As to claim 4,* Dakshina-Murthy discloses hydrocarbon compounds such as ethylene, propylene, methane and the like (col.5, lines 48)

*As claim 5,* Dakshina-Murthy discloses inert ions may be introduced into the amorphous carbon layer (column 6, line 33). One of ordinary skill in the art would also know that inert gases are conventionally used for diluting gases in plasma, which is a way of introducing inert ions during deposition.

*As claim 7,* Dakshina-Murthy discloses "One advantageous feature of providing amorphous carbon layer 60 that may be produced with various thicknesses is that amorphous carbon layer 60 may be produced in a thickness suitable for patterning layer of conductive or semiconductive material 50. For example, where a particular thickness of polysilicon is provided, the thickness of amorphous carbon layer 60 may be altered so that the proper amount of mask material is provided over the polysilicon material to compensate for the etch selectivities of the materials used. This allows for increased manufacturing

efficiency by eliminating unnecessary material use" (column 5, line 64) which means one of ordinary skill in the art could select the desired selectivity.

As to claim 8, Dakshina-Murthy discloses an ARC layer (70) (column 7, line 10).

***Claim Rejections - 35 USC § 103***

2. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Dakshina-Murthy et al. (US 6,884,733) in view of Godet, *Jounal of Applied Physics, Vol.84, 3919, (1998)* and Lee (US Patent No. 6, 043,167) as applied to claim 1 above, in further view of Yang (Pub. No. 2003/0003771).

Dakshina-Murthy fails to disclose a dual-frequency plasma for the PECVD deposition. However, Yang discloses a dual frequency that includes high frequency of 200 Watts at 13.56 MHz and a low frequency of 200 Watts and 500KHz (paragraph 0016). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the process of Dakshina-Murthy to use the frequencies and power levels as described above because Yang illustrates the use proven deposition conditions disclosed in the literature in order to obtain a reliable product while reducing costly process development time.

***Claim Rejections - 35 USC § 103***

3. Claims 9, 11-13, 15-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dakshina-Murthy et al. (US 6,884,733) in view of Godet,

*Jounal of Applied Physics, Vol.84, 3919, (1998)* and Lee (US Patent No. 6, 043,167).

Dakshina-Murthy discloses use of amorphous carbon hard mask for gate patterning, the method comprises forming a conductive material layer (50) on a surface of the substrate (column 4, lines 53-64), depositing an amorphous carbon layer (60) on the conductive material layer (column 5, line 42) by a method comprising: introducing into the processing chamber one or more hydrocarbon compounds having the general formula CxHy such as Ethylene or propylene (column 5, line 48). And generating a plasma of the one or more hydrocarbon compounds (column 5, line 49) depositing an anti-reflective coating (70) on the amorphous carbon hard mask (figure 5) depositing a patterned resist material (80) on the anti-reflective coating, etching the anti-reflective coating and amorphous carbon hardmask to the conductive material layer (figure 8) (col.8, lines 38-43), and etching feature definitions in the conductive material layer (figure 9).

Dakshina-Murthy, fails to disclose a dual-frequency plasma for the PECVD deposition. However, Godet discloses surface wave coupled microwave MW at 2.45 GHz and capacitively coupled RF at 13.56 MHz for the deposition plasma (page 3920, paragraph 4). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the process of Dakshina-Murthy to use the frequencies and power levels as described above because those condition are disclosed by Godet. One of

ordinary skill in the art would have been motivated to use proven deposition conditions disclosed in the literature in order to obtain a reliable product while reducing costly process development time.

Dakshina-Murthy fails to disclose the first frequency between about 10MHz-30MHz and second frequency between about 100KHz-500KHz. However, Lee discloses the dual frequency of about 13.56 MHZ for the first frequency and about 10KHz-100Kz for the second frequency (col.3, lines 48-59). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to select dual frequency values for the RF source because Lee illustrates that the low dielectric constant insulating films such as amorphous fluorocarbon film when deposited with a dual frequency RF source result in a stable low-k film at least up to 450°C with low internal stress (col.3, lines 1-3).

*As to claim 12,* Dakshina-Murthy discloses hydrocarbon compounds such as ethylene, propylene, methane and the like (col.5, line 48).

*As claim 13,* Dakshina-Murthy discloses inert ions may be introduced into the amorphous carbon layer (column 6, line 33). One of ordinary skill in the art would also know that inert gases are conventionally used for diluting gases in plasma, which is a way of introducing inert ions during deposition.

*As to claim 15,* Dakshina-Murthy discloses an ARC layer (70) made of silicon nitride (column 7, line 12).

*As to claim 17,* Dakshina-Murthy shows all photoresist (88 and 90) is removed (figure 8) prior to etching conductive layer (50).

*As claim 18,* Dakshina-Murthy discloses "One advantageous feature of providing amorphous carbon layer 60 that may be produced with various thicknesses is that amorphous carbon layer 60 may be produced in a thickness suitable for patterning layer of conductive or semiconductive material 50. For example, where a particular thickness of polysilicon is provided, the thickness of amorphous carbon layer 60 may be altered so that the proper amount of mask material is provided over the polysilicon material to compensate for the etch selectivities of the materials used. This allows for increased manufacturing efficiency by eliminating unnecessary material use" (column 5, line 64) which means one of ordinary skill in the art could select the desired selectivity.

***Claim Rejections - 35 USC § 103***

5. Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Dakshina-Murthy et al. (US 6,884,733) in view of Godet, *Jounal of Applied Physics, Vol.84, 3919, (1998)* and Lee (US Patent No. 6, 043,167) as applied to claim 9, above in further view of Yang (US Pub. No. 2003/0003771).

Dakshina-Murthy fails to disclose a barrier layer. The reference of Yang cites it is conventional to deposit a barrier layer (136) prior to deposition of the conductive layer (page 5, paragraph 0057). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to

modify the process of Dakshina-Murthy to add the step of depositing a barrier layer prior to deposition of the conductive layer because the reference of Yang teaches barrier layers are conventionally used. One of ordinary skill in the art would have been motivated to use a barrier layer in order to prevent diffusion of the conductive material into the adjacent layer(s).

***Claim Rejections - 35 USC § 103***

6. Claims 19-21, 23-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dakshina-Murthy et al. (US 6,884,733) in view of Godet, *Jounal of Applied Physics, Vol.84, 3919, (1998),* Lee (US Patent No. 6, 043,167) and Park et al. (US 2004/0224241).

As to claim 19, 23-24, all the limitations in applicant's claim 19 have been addressed in reference to rejections of claims 1, 3-9, and 11-18 above, namely: a method for processing a substrate in a chamber, forming an aluminum-containing layer on a surface of the substrate depositing an amorphous carbon hardmask on the aluminum-containing layer by a method comprising: introducing into the processing chamber one or more hydrocarbon compounds having the general formula CxHy, wherein x has a ranqe of 2 to 4 and y has a range of 2 to 10 (see claim 1), and generating a plasma of the one or more hydrocarbon compounds by applying power from a dual-frequency RF source (see claim 1 above), depositing an anti-reflective coating on the amorphous carbon hardmask, wherein the anti-reflective coating is a material selected from the group of silicon

nitride, silicon carbide, carbon-doped silicon oxide, amorphous carbon, and combinations thereof (see claims 8, 9), depositing a patterned resist material on the anti-reflective coating (see claim 9),etching the anti-reflective coating and amomhous carbon hardmask to the aluminum-containing layer (see claim 9 above);removing the resist material (see claim 17 above), etching feature definitions in the aluminum-containing layer at an etch selectivity of amorphous carbon to the aluminum-containing between about 1:3 and about 1:10 (see claim 18 above). As to the limitation of removing the one or more amorphous carbon layers by exposing the one or more amorphous carbon Layers to a plasma of a hydrogen-containing gas or an oxygen-containing gas, Dakshina-Murthy discloses "In a step 310, amorphous carbon features 62, 64 are removed after layer of conductive or semiconductive material 50 is patterned (e.g., to form gate conductors 30, 32 shown in FIG. 1). Amorphous carbon features 62, 64 may be removed using methods similar to those described above. For example, the amorphous carbon may be removed using an oxygen-containing plasma_(column 8, line 63).

Dakshina-Murthy fails to disclose the first frequency between about 10MHz-30MHz and second frequency between about 100KHz-500KHz. However, Lee discloses the dual frequency of about 13.56 MHZ (at 300W) (col.4, lines 36-37) for the first frequency and about 10KHz-100Kz (at –200V)(col.4, line 43) for the second frequency (col.3, lines 48-59). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to

select dual frequency values for the RF source because Lee illustrates that the low dielectric constant insulating films such as amorphous fluorocarbon film when deposited with a dual frequency RF source result in a stable low-k film at least up to 450°C with low internal stress (col.3, lines 1-3).

*As to claim 20,* Dakshina-Murthy discloses hydrocarbon compounds such ethylene, propylene, methane, and the like (col.5, line 48).

*As claim 21,* Dakshina-Murthy discloses inert ions may be introduced into the amorphous carbon layer (column 6, line 33). One of ordinary skill in the art would also know that inert gases are conventionally used for diluting gases in plasma, which is a way of introducing inert ions during deposition.

***Response to Arguments***

7. Applicant's arguments with respect to claims 1, 3-9 and 11-22 have been considered but are moot in view of the new ground(s) of rejection.

*(a) With respect to claim 1, 9 and 11-18,* the new applied art of Lee (US Patent No. 6, 043,167) discloses dual-frequency RF source with the range of first and second frequencies as defined in the claims 1 and 9. The reference of Lee discloses the formation of amorphous fluorocarbon films that have low dielectric constant. The reference of Dakshina-Murthy discloses a method for processing a substrate in a processing chamber for forming an amorphous carbon layer (60) on the conductive material layer (50(Fig.3)(col.6, lines 8-10).

*(b) With respect to claims 19-22,* the combined reference of Murthy, Godet, Park and Lee meet all the limitations defined in these claims (see discussions on pages 9-10 above).

***Conclusion***

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Maki Angadi whose telephone number is (571)272-8213. The examiner can normally be reached on week days from 8:00 AM. to 5:00 PM..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on (571) 272-1465. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Dr. Maki Angadi
Examiner
Art Unit 1765

NADINE NORTON
SUPERVISORY PATENT EXAMINER
ART UNIT 1765